FOUNTAIN PAINT POT NATURE TRAIL

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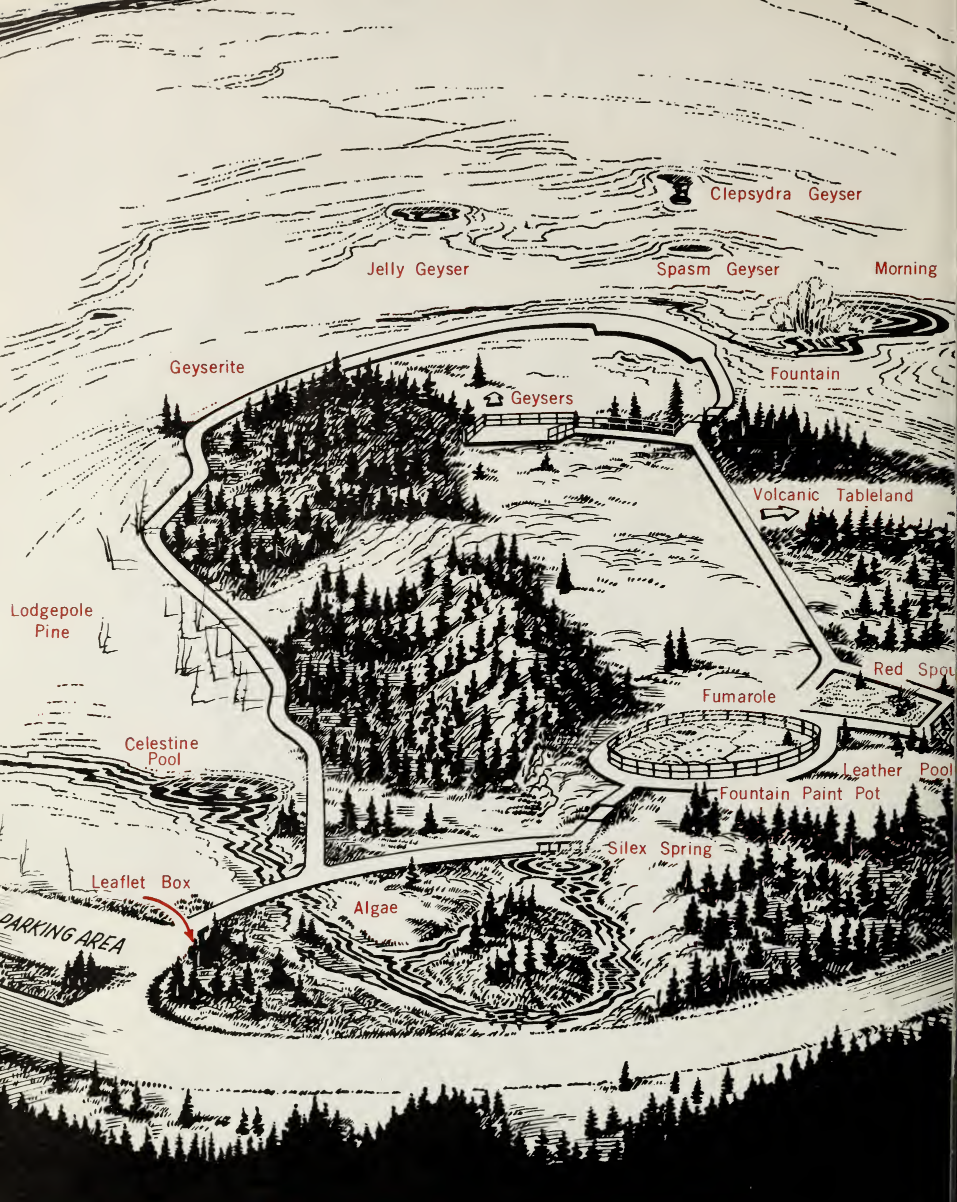

FOUNTAIN PAINT POT NATURE TRAIL

Bill Chapman.

INTRODUCTION

Are you looking for geysers? Mud pots? Here is a good place to see them. The boardwalk trail leads first to a typical group of mud pots. Further along the trail you can watch a half dozen geysers playing at the same time.

Carry this booklet with you. It explains a few things along the way such as hot springs, geysers, paint pots and steam vents. We hope this booklet will help you understand the natural features. The trail is a half-mile long.

There is a wild yet delicate scene ahead. The boardwalk will guide you by the safest route. Please stay on it and do nothing that might harm you or one of the rare features.

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ALGAE

The ribbons of color that stream from hot springs are usually formed by plants called algae. They are common in ponds, streams, oceans and wet places throughout the world.

Carefully touch the water above the green algae. Now touch the water above the orange algae. Notice the difference in temperature? Th colors serve as temperature indicators.

At this stop it is safe to feel the water. Do not touch hot spring waters elsewhere. The algae can live in even hotter water, where you could be scalded!

Hot spring algae are wonders of life at high temperatures. Some live in waters as hot as 167° F. At this temperature the plants are usually yellow but become darker — orange, red, or brown — as the water cools. Between 115°F and 130°F other species may appear which will modify the colors even more. Certain varieties are scientific curiosities, because they are extremely specific for their environment. They may be found around the world living only in hot spring waters.

Not all of the natural colors in hot springs are due to algae. Yellow or pink strands of bacteria sometimes appear in water as hot as 195°F, just below the boiling point. (Water boils at 198°F at this elevation.) Chemical deposits of sulfur, iron oxides, arsenic sulfide, and other substances add vivid colors to hot springs, especially in the Norris Geyser Basin.

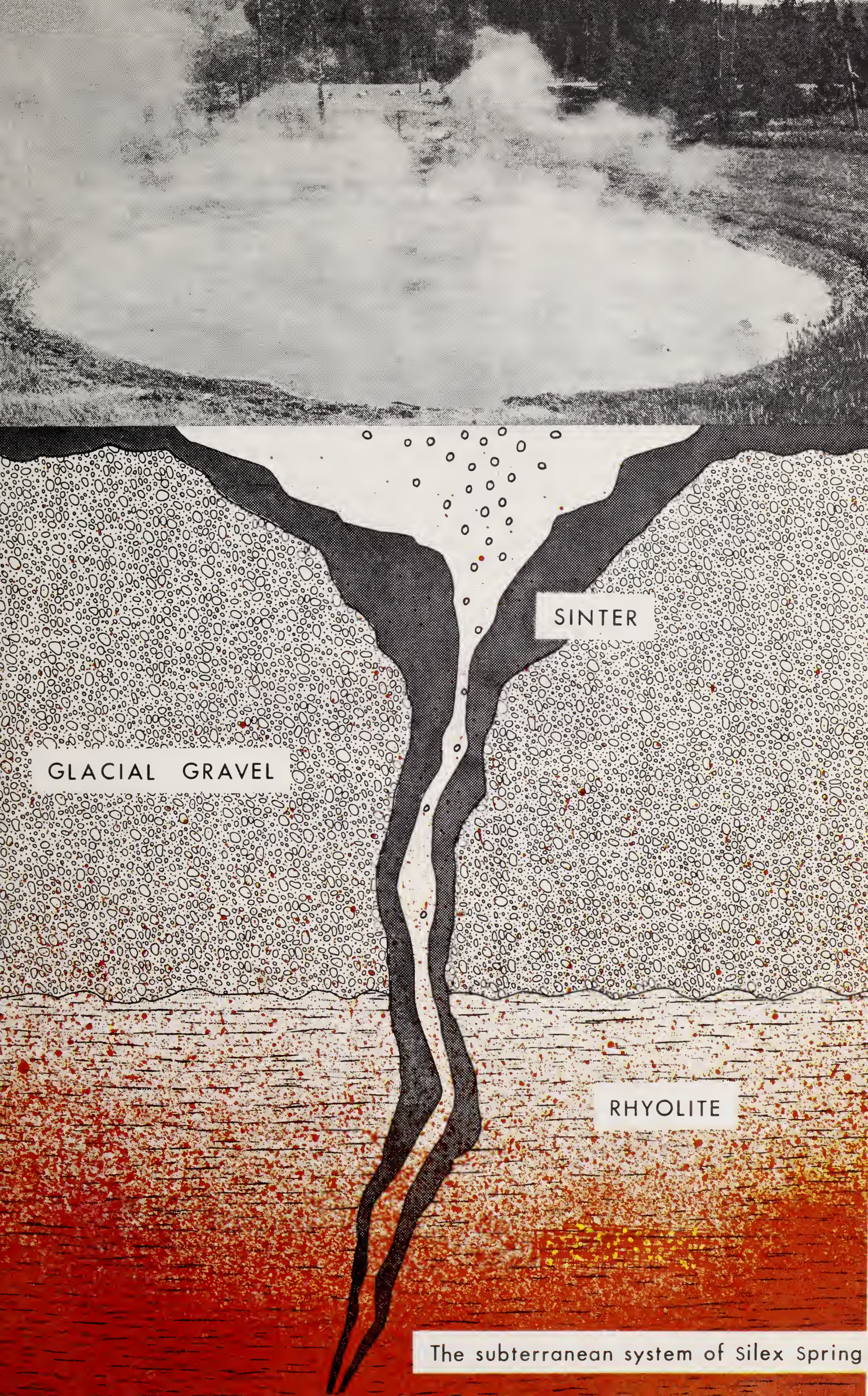
SILEX SPRING

Along the trail you will see hydrothermal features, expressions of Yellowstone's volcanism. No two features are exactly alike, yet they can be grouped into:

(a) those that have a lot of water; hot springs and geysers
(b) those that have a limited amount of water; paint pots and mud volcanoes
(c) those that have steam, but no liquid water; fumaroles

Deep in the earth beneath you the molten rock of the earth's interior transmits heat upward through solid rock to ground water which has penetrated to that depth. The extremely hot water that results forces its way upward through fissures and fractures, warming rocks and water as it goes. Where the hot water can escape at the ground surface, a hot spring it formed. The diagram shows how a hot spring may appear in cross section.

UPP



The subterranean system of Silex Spring

Two properties of the extremely hot water are important in the development of the plumbing system of a hot spring. First of all very hot water has a lower viscosity, so that it can flow faster through small channels. Secondly, it is a much better solvent than the cooler waters we are accustomed to at the earth's surface. It dissolves astounding amounts of silica, a common component of volcanic rocks. In this way small channels are enlarged and the water can move more freely.

Uncommon elements such as lithium, fluorine, arsenic and boron are contained in the substances dissolved by the hot waters and carried to the surface. There they may be deposited in the spring or in the runoff channels. Silica, sometimes called silex, is the gray to white deposit that lines the bottom of the spring and forms terraces along the runoff channels.

Silex Spring's water supply is so great that it overflows most of the time. Throughout the year the overflow provides a limited hot environment for the algae. The algae in turn are the food base for a community of mites, spiders, flies and various insects that live on the hot water and in the warm air layer just above it. But in the pool and at the head of the overflow, the water temperature is too great for such life. It ranges from 188°F to 199°F, just below the boiling point.

Let's go to the next stop and look at a paint pot.

FOUNTAIN PAINT POT

In climbing the slope from Silex spring you have reached an area which has a variable supply of surface water. In early summer the muds are quite thin and watery. By late summer the mud becomes quite thick. The bubbling action which is caused by steam

steam bubble bursting in the Fountain Paint Pot.

changes as the mud thickens. If the mud is thick today, watch out! Occasionally the bursting bubbles lob mud up and over the guard rail.

The most powerful springs of this type are in the Mud Volcano area six miles north of Fishing Bridge.

Why should the water supply vary so greatly between Silex Spring and Fountain Paint Pot? While several conditions may affect the upper level of ground water (or water table), here it appears that the water table is near the surface of the ground at the spring but is deeper down at the Paint Pot. Water tables rise under hills but do not come as close to the surface as in low places. The water table is usually nearest the surface at the base of a hill and that is where springs frequently appear. When there is a bountiful water supply, the water table rises high enough to noticeably dilute the paint pot.

The mud is composed of clay and fine particles of silica. It is created by chemical decomposition of rock minerals and by mechanical pulverization as hard particles grind against one another. Since there is no overflow, the muds are trapped in the paint pots and are ever increasing in quantity.

The local rock is largely rhyolite which is primarily silica and feldspar. Acids in the stream and water break down the feldspar into hydrous aluminum silicates or, as they are better known, clays. Kaolinite is the most prevalent clay mineral here. The clay is white when pure, but changes through shades of orange, pink and red when it is contaminated with iron oxides.

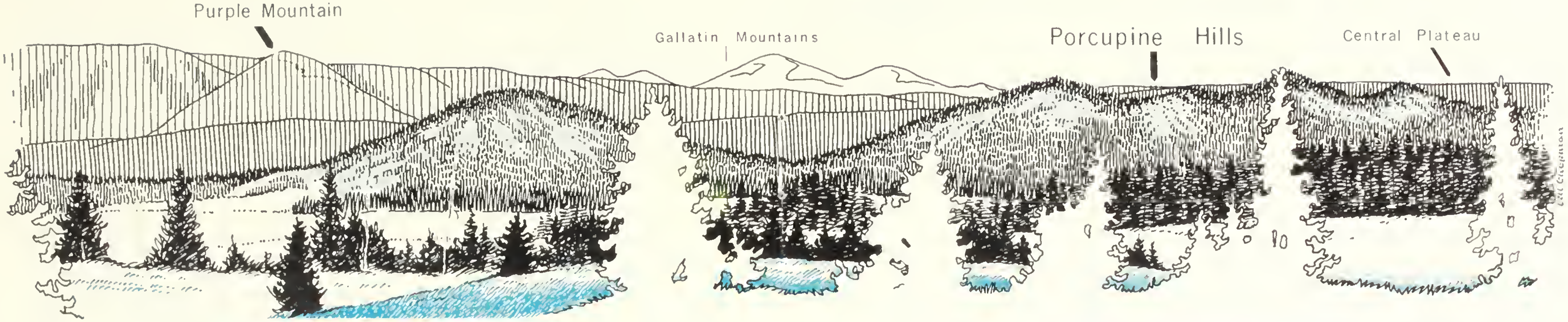
A FUMAROLE

Gases — steam, carbon dioxide and a little hydrogen sulfide — rush from the earth through this vent. The steam comes from the limited amount of ground water that seeps down to the zone of very hot rock. On contact with the rock it flashes into steam. The sudden increase in volume, nearly 2,000 times, produces the pressure which drives the gases from the vent.

Isotopic analyses of water from hot springs around the world indicate that 95 to 99% of the water in hot springs, fumaroles, etc. is water that has fallen to the earth's surface as rain or snow. Very little, if any, of the water is juvenile water, that is, water evolved from the molten rock or magma of the earth's interior.

Great problems remain unsolved: What is the true nature of the heat source? How is it shaped? How far down is it? Is it primary magma or a still cooling buried pile of lava flows?

THE VOLCANIC TABLELAND



LEATHER POOL

Hot springs are in a constant state of change. Usually the changes are almost imperceptible except upon comparison of records. Abrupt changes occur during earthquakes. The Hebgen Lake earthquake of 1959 changed this pool. Before the earthquake it was a warm pool, about 143 F. Leather-like brown algae lined the bowl. With the earthquake, the water temperature rose to boiling, killing the brown algae. The temperature still remains aove the critical point for algal life.

Geologically speaking, hot springs are very fragile. Glacial gravel is unstable material and in this basin the gravel is honeycombed by the sinuous roots of springs. The basin is particularly vulnerable to earthquakes. The jarring energy of a quake can make gravel bounce atop solid rock as does a marble on a wood floor that is hit by a hammer. As the gravel particles vibrate, their positions are readjusted. Compaction usually results and water displaced from around rock particles is forced to the surface carrying muddy material that clouds surface pools. Fractures accompany compaction and water levels in some springs drop as their discharge is diverted. Others increase in temperature as a steam and hot water are directly led to them through newly opened fissures.

In the days after the Hebgen Earthquake, all of the above changes were observed in various springs of the Firehole geyser basins. The epicenter of the quake was determined to be about 31 miles airline northwest of here.

RED SPOUTER

This spring originated with the Hebgen Earthquake. It shows tremendous changes through the seasons. During the summer it is a fumarole, but from late fall to early summer it spouts brilliant red water.

Red Spouter's activities vary with the fluctuating water table. Note that it is situated on the hill higher than Leather Pool and lower than the paint pots and fumarole. As the water table rises and falls with the seasons, Red Spouter passes through phases of being either a fumarole or a watery paint pot. It has never yet received enough water to become a pool.

THE VOLCANIC TABLELAND

The view to the north is a panorama of the major events of Yellowstone's geologic past. These events have led to the weird features of this basin.

1. The landscape had its beginning when the earth's crust was bent, fractured and heaved into high mountain ranges such as the Gallatin.

2. Volcanos showered the region with ash and rock fragments. The bulk of the Yellowstone Plateau grew as rhyolite lavas flowed across the land beneath holocausts of incandescent clouds. The horizontal skylines of the Purple Mountain area and Central Plateau indicate the tops of lava flows.

3, Ice buried the land during the Ice Age. An ice cap that covered the center of the park sent glaciers over the plateau into the valleys of the Firehole, Gibbon and Madison Rivers.

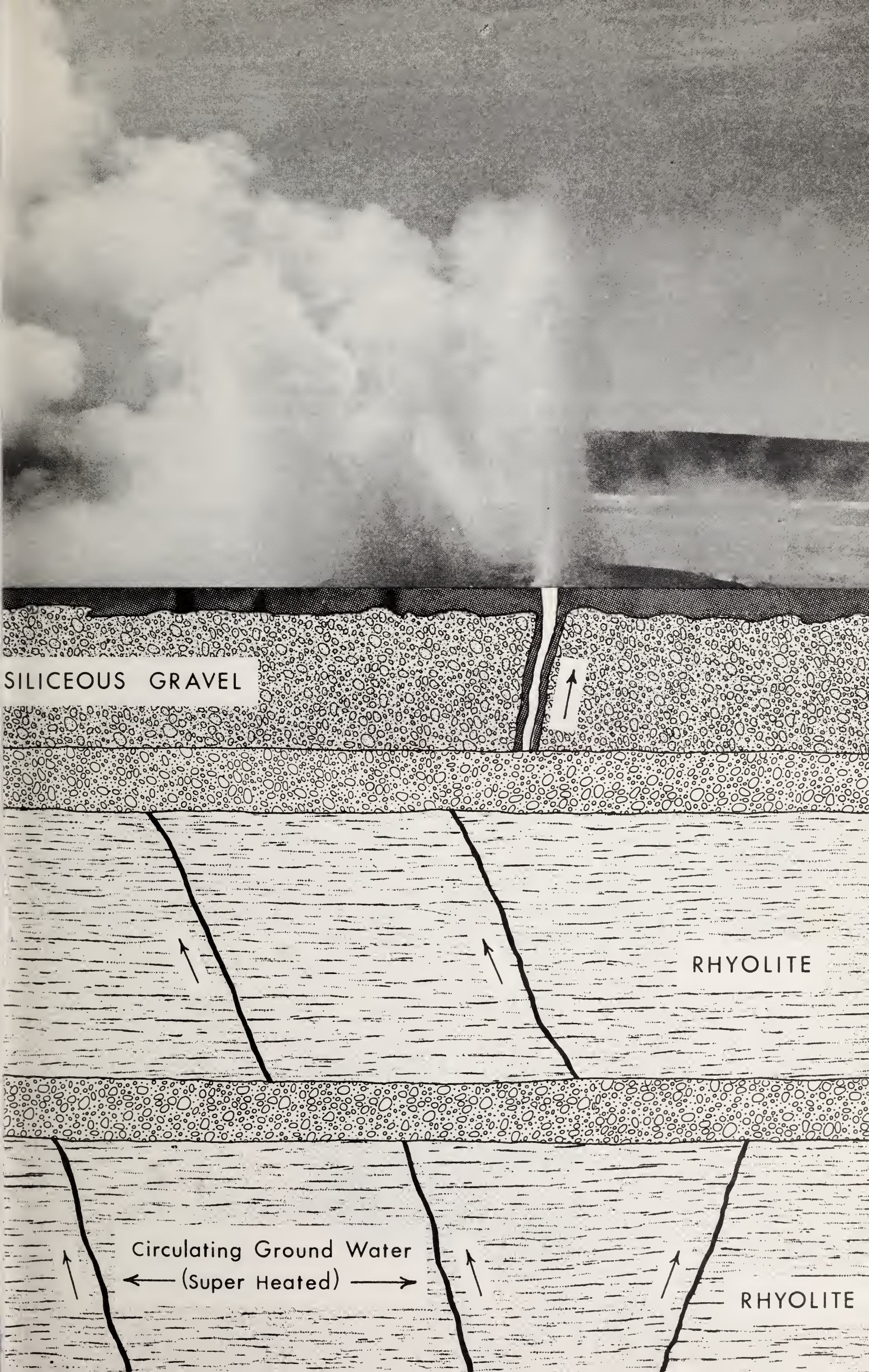
4. Hot springs had formed at the edges of the lava flows. Ice swept over them, only to be melted so rapidly that great heaps of gravel formed. The Porcupine Hills are just such gravel heaps. On cold mornings, one can see steam rising from the hot springs even today.

Such are the events of the last 70 million years that are portrayed here. And they continue. The combination of events has set the stage for Yellowstone's most improbable wonders . . . geysers. When you reach the next viewpoint, a half dozen geysers may be playing at the same time.

GEYSERS

Before you is the liveliest collection of geysers in the Park. Take a moment to spot the numerous locations where you see water leaping skyward. What is a geyser? A geyser is a hot spring that intermittently gushes forth water. This phenomenon occurs at only a few places in the world and it is rare in those locations. Ten percent of the Yellowstone hot springs are geysers whereas in Iceland only one percent are geysers. The world's geysers are concentratd in Yellowstone and many of them play to great heights.

The essentials for geysers are combined in Yellowstone: sufficient annual precipitation; continuous flow of volcanic heat; tight, but fractured beds of rhyolite; and permeable rock layers such as gravel beds and altered rhyolite strata. Hot waters have leached silica from rhyolite, depositing it at the surface to seal the permeable gravels, in effect putting the lid on nature's pressure cooker. This lid enables the cemented gravels to withstand the pressures that develop in the steam explosions which occur when a geyser erupts.

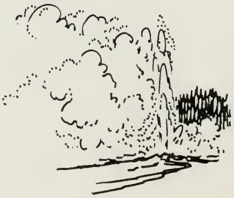

SILICEOUS GRAVEL
RHYOLITE
Circulating Ground Water
(Super Heated)
RHYOLITE

Numerous theories have been proposed to explain how a geyser works. Steam explosions are generally considered to provide the driving force for an eruption. The problem is to find out what causes a steam explosion to start. One theory suggests that gas bubbles form as the hot water rises and the pressure on that water decreases. As the bubbles become large enough and numerous enough, they prevent water from flowing around them. Instead, the water at the top of the column is pushed up and out of the geyser vent. This will cause a sudden reduction in the pressure on the water below. At some point in the water column, where the water is hot enough, the sudden reduction in pressure will cause the water to explode into steam. The water above the explosion will be driven from the geyser. The eruption is on. It will continue until the available water is used up. Many variations of behavior occur in geysers, apparently because of differences in the amount of water that is available, the temperature of the rocks of the plumbing system at system, the temperature of the rocks of the plumbing system at the time of the eruption, the narrowness and contortions of the plumbing system, etc.

On the basis of the theory described above, the difference between a hot spring and a geyser lies in the ability of a hot spring to accommodate the larger bubbles as they form. In addition, a hot spring usually dissipates large quantities of energy through convection and evaporation into the air at its surface.

CLEPSYDRA GEYSER

The behavior of all the geysers in this basin was profoundly affected by the 1959 earthquake. Before the quake, Clepsydra Geyser frequently spurted from the central vent. After the earthquake, it went wild and began erupting steadily. In the past few years it has stopped playing for a few minutes, once in awhile. It may gradually return to its pre-earthquake behavior.

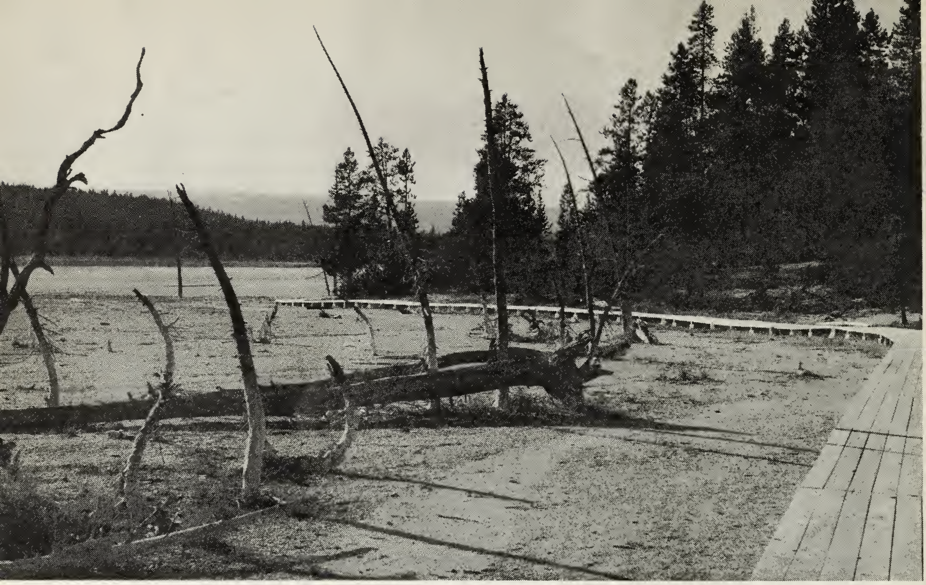


GEYSERITE

This broad, gray-white mound is being built by the geysers. Geyserite, as the rock is called, is really opal, a form of the common mineral silica that contains a little water. Largely a product of cooling and evaporation of hot spring water, it is often named 'siliceous sinter.' The process of deposition is a mystery. Certainly an insoluble residue readily forms on anything, including eyeglasses, when the water evaporates. It must also be deposited as the water cools as it rises in the hot spring systems. How else could it form the lining of the plumbing system of geysers and hot springs?

There are several hot spring basins on the way to Old Faithful. Geyserite is building up in these basins. Each spring adds to the layers around it which merge with geyserite from a neighboring spring. Nine miles of the Firehole valley is "plated" with sinter. The first of the sinter was probably deposited as the glacial ice retreated. The sinter accumulates at different rates depending on the character of the water in each spring and the rate at which erosion removes it. All factors considered it must have taken thousands of years to build this sinter mound.

The sinter is so fragile that it often cracks and shatters when people step on it. Therefore, the Park Service has installed boardwalks in the geyser area as a way of protecting the features as well as to provide a safe path for you to walk on.



Lodgepole Pine skeletons—drowned by a shift in hot spring run-off waters.

LODGEPOLE PINES

Besides silica, sinter contains a variety of materials carried in hot water plus debris from the life that once existed on it. Minerals, bits of organic matter, even the litter that man unconsciously leaves behind, all become cemented with the silica. Pioneering Lodgepole Pine trees grow in and near the margins of the sinter.

When hot water from the springs changes direction and floods around the pines, the trees are drowned. Water continues to move through the cells of the bases of the trees, carrying minerals into the wood. In this way the wood becomes partially petrified. Such was the fate of the dead trees beside the walk. You will see many similar trees throughout the geyser basins, further evidence of the changes that are typical of Yellowstone.

The National Park System is dedicated to the conservation of America's scenic, scientific, and historic heritage for the benefit and enjoyment of the people.

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YOU MAY PURCHASE IT BY LEAVING 15c IN THE COIN RECEPTACLE

If you would like to learn more about Yellowstone's geology the following publications will be of help:

The Story of Old Faithful Geyser, George D. Marler.

Studies of Geysers and Hot Springs Along the Firehole River, George D. Marler.

Yellowstone's Living Geology, William A. Fischer.

These are sold by the Yellowstone Library and Museum Association and may be purchased at visitor centers around the Park. The Yellowstone Library and Museum Association is a non-profit educational society organized to assist the interpretive program of Yellowstone National Park.

Bill Chapman